

People and our Planet



Presentation to EPSCoR Project Directors and Project Administrators

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May 16, 2011

Towards a Sustainable Human Future

*Whether it's improving our health or harnessing clean energy, protecting our security or succeeding in the global economy, our future depends on reaffirming America's role as the **world's engine of scientific discovery and technological innovation**.*

– President Barack Obama

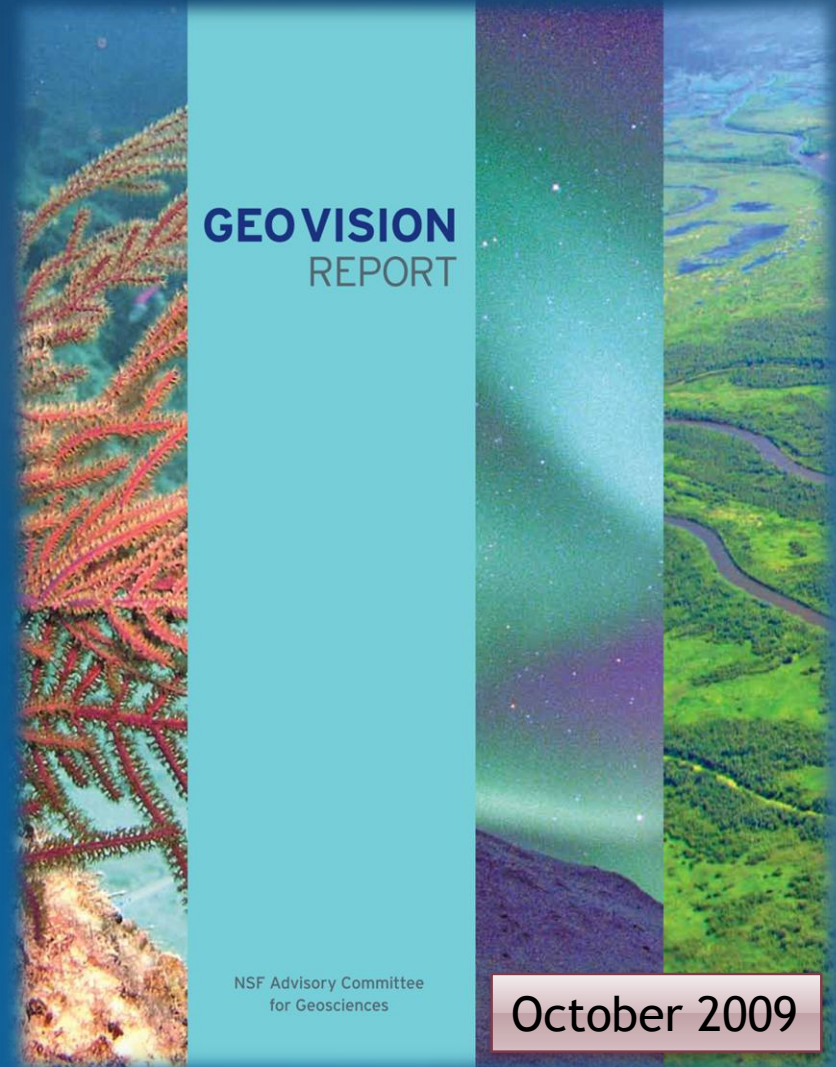


*Of all the challenges we face as a nation and as a planet, none is as pressing as the three-pronged challenge of **climate change, sustainable development** and the need to foster **new and cleaner sources of energy**.*

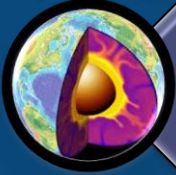
(Office of Science and Technology Policy, Executive Office of the President)

GEO Vision

“To understand more deeply the planet and its interactions will require the geosciences to take an increasingly holistic approach, exploring knowledge coming from all scientific and engineering disciplines.”



Geosciences at a Crossroads



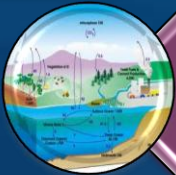
The Dynamic Earth



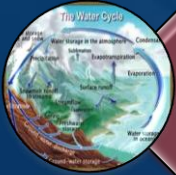
The Changing Climate



Earth and Life



Geosphere-Biosphere Connection



Water: Changing Perspectives

“...the most urgent issues that pose unique and sustained hazards for the Earth and its inhabitants.”

Energy consumption growing



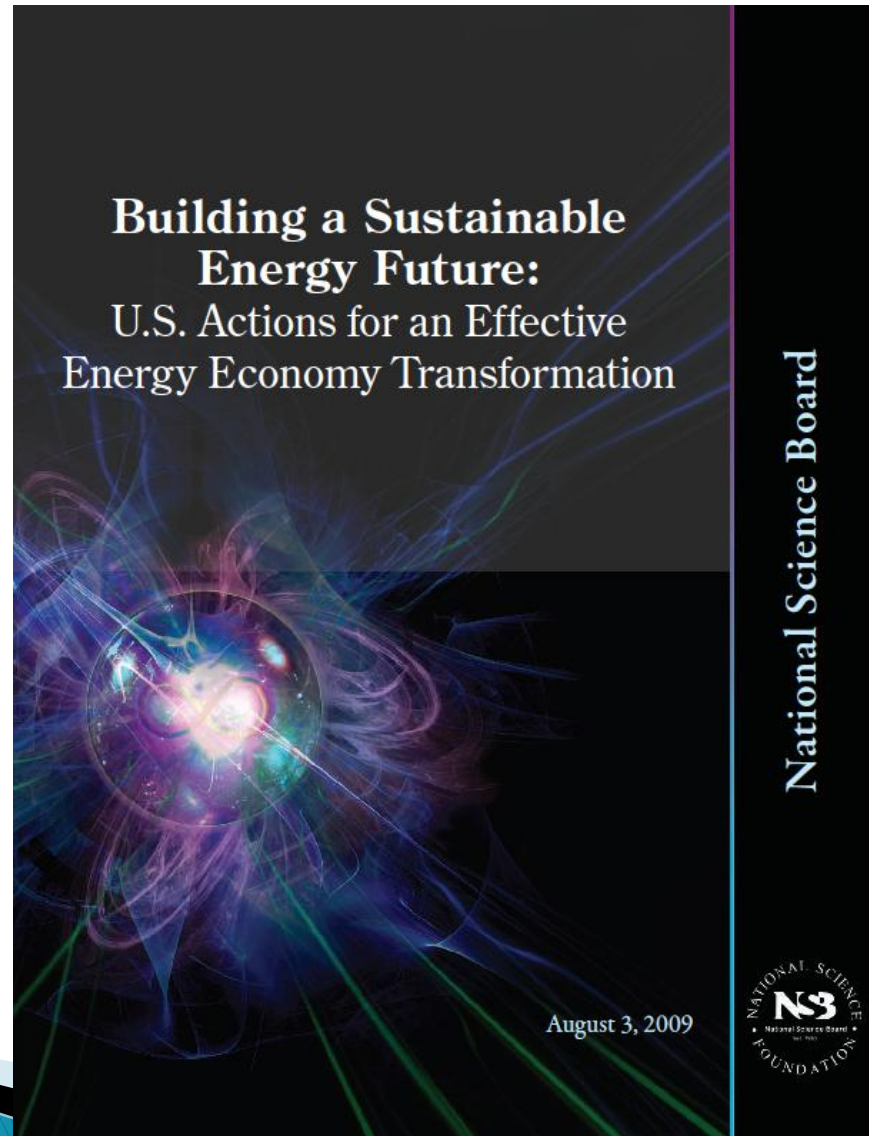
today

... to unprecedented demands



2030

National Science Board Guidance



**Building a Sustainable
Energy Future:**
U.S. Actions for an Effective
Energy Economy Transformation

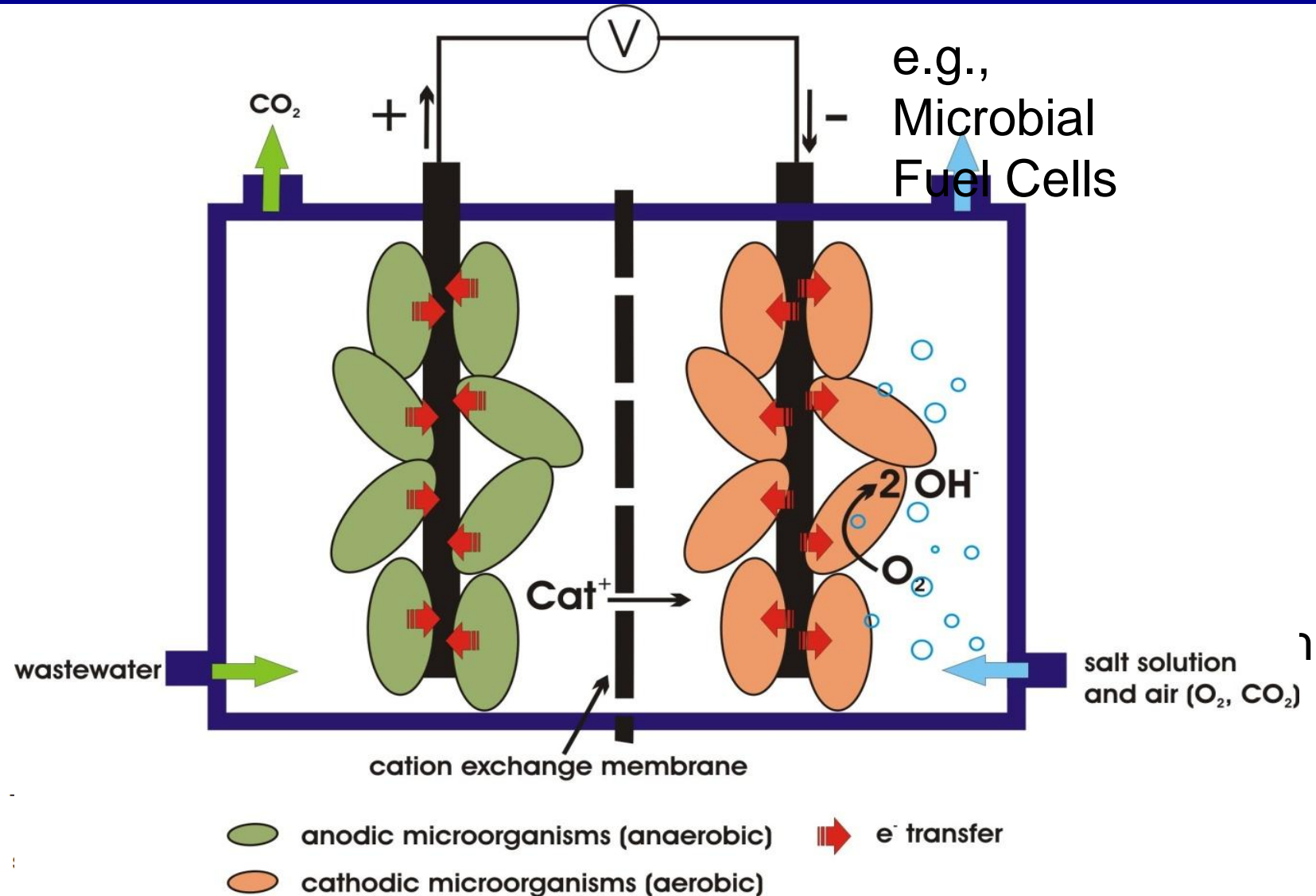
August 3, 2009

National Science Board



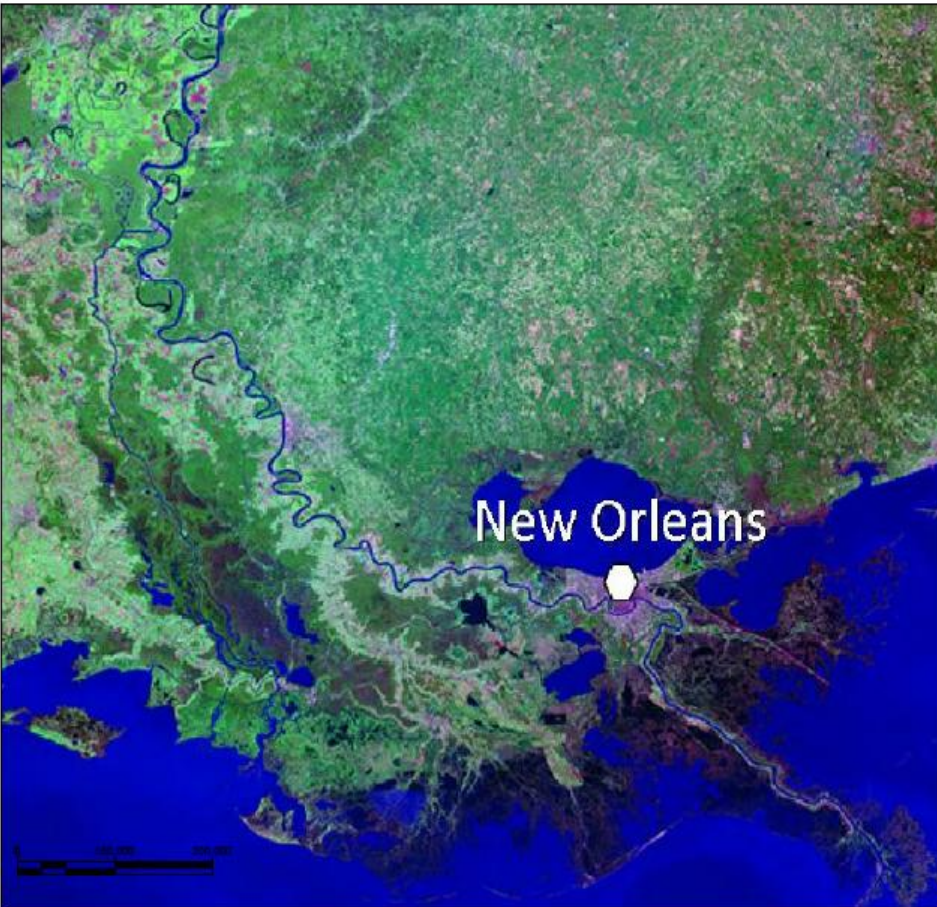
“Green” Energy technologies for Greenhouse Gas Abatement

Beyond business as usual 2030



Changes that can affect us

Year - 2009



Year - 2100



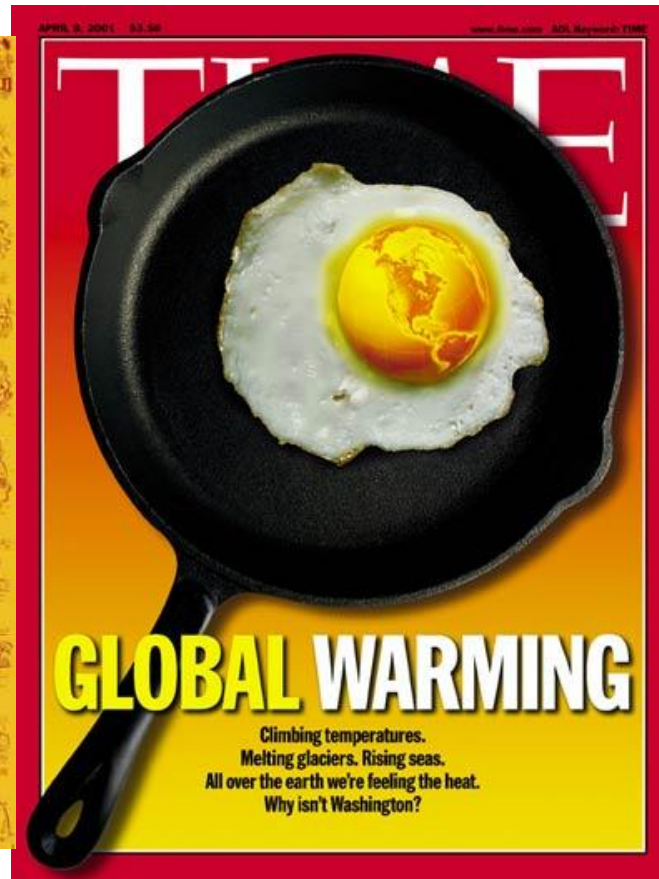
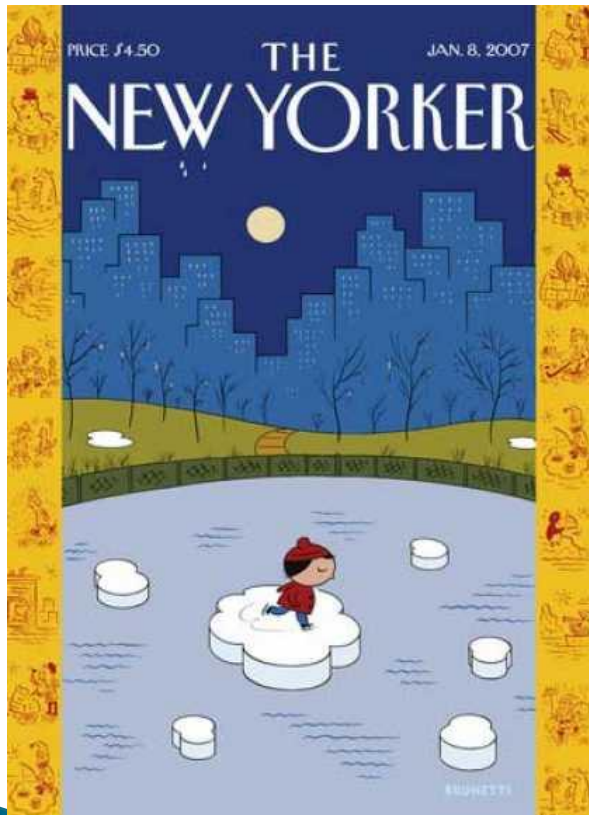
Map: Blum, M.D., and H.H. Roberts (2009), Drowning of the Mississippi delta due to insufficient sediment supply and global sea-level rise, *Nat. Geosci.*, 2, 488-491.

Mississippi River & Tributaries (MRT)



The Flood Control Act of 1928 put flood control on par with other major projects of its time with the largest public works appropriation ever.

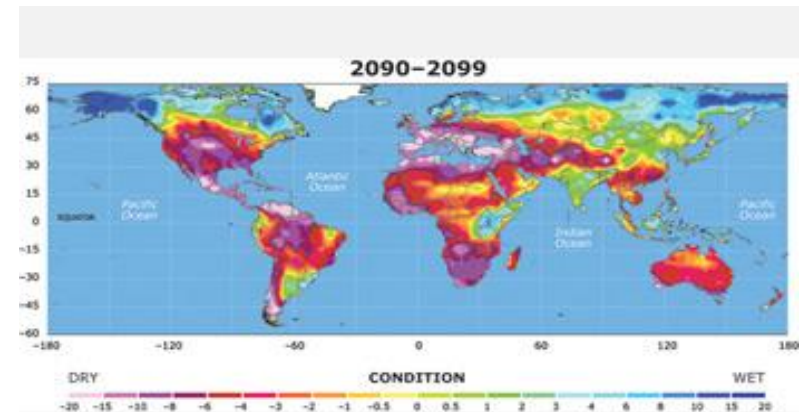
Society demands reliable projections of coming changes...



Sustainability Science, Engineering and Education

- ▶ National Academy of Sciences definition:
“The interactions between **natural and social systems** and how those interactions affect the challenge of **sustainability**:
sustainability:
▶ ...meeting the needs of present and future generations while substantially reducing poverty and conserving the planet’s life support systems”

www.pnas.org/site/misc/sustainability.shtml



NSF SEES Overview

- ▶ Established FY10, Planned to continue thru FY15
- ▶ Involves all NSF research and education Directorates and offices
Initially focused on the intersection of climate and environment, including specific attention to incorporating the human sciences
- ▶ Encouraged a systems-based approach to understanding, predicting, and reacting to change in the linked natural, social, and built environment.



Environmental Research and Education



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Proposals and Awards

Proposal and Award Policies and Procedures Guide

Introduction

Proposal Preparation and
Submission

- ♦ [Grant Proposal Guide](#)
- ♦ [Grants.gov Application Guide](#)

Award and Administration

- ♦ [Award and Administration Guide](#)

Science, Engineering and Education for Sustainability (SEES) NSF-Wide Investment

NSF established the Science, Engineering, and Education for Sustainability (SEES) investment area in FY 2010 in order to address challenges in climate and energy research and education using a systems-based approach to understanding, predicting, and reacting to change in the linked natural, social, and built environment. Initial efforts were focused on coordination of a suite of research and education programs at the intersection of climate and environment, including specific attention to incorporating human dimensions.

SEES is expected to be a 5-year effort, extending through FY15. Continuing efforts will focus on supporting research that facilitates global community sustainability, specifically through building connections between current projects, creating new nodes of activity, and developing personnel needed to solve sustainability issues. Future efforts will be expanded to include sustainable energy research in science and engineering, and its socioeconomic and environmental

[SEES News &
Updates](#)

[SEES News Releases](#)

[SEES FY 2011
Activities](#)

[SEES FY 2010
Activities](#)

[SEES Portfolio &
Highlights](#)



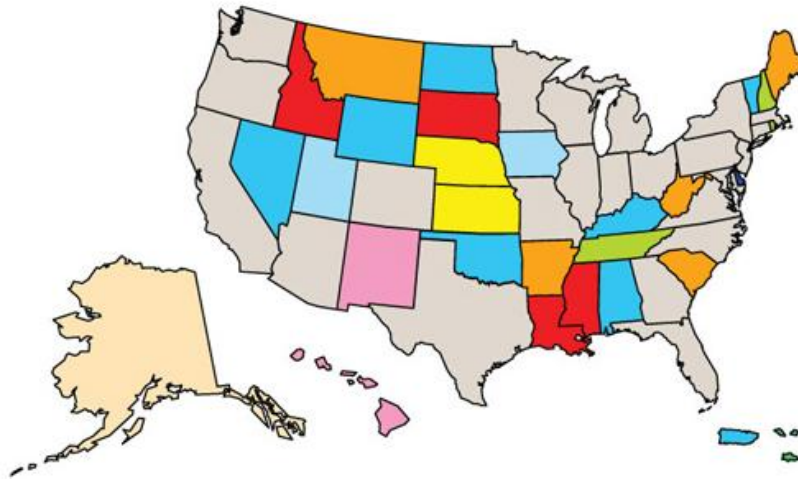
SEES Major Aims

- ▶ Support **research and education** to inform global community sustainability
- ▶ Build **connections** between current projects and create new nodes of activity
- ▶ Develop **personnel** needed to understand complex issues of sustainability

Some specific SEES portfolio examples:

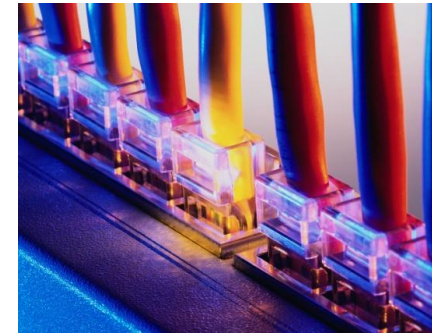
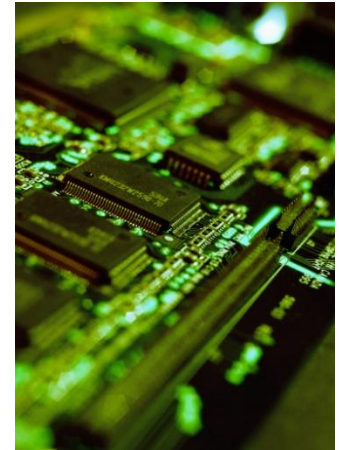
- ▶ research at the energy–environment–society nexus
- ▶ novel energy production, harvesting, storage, transmission, and distribution technologies
- ▶ corresponding adoption, socioeconomic, and policy issues
- ▶ innovative computational science and engineering methods and systems for monitoring, understanding and optimizing life–cycle energy costs and carbon footprints of natural, social and built systems
- ▶ study of societal factors such as vulnerability and resilience, and sensitivity to regional change

Many EPSCoR Programs have a strong Sustainability Focus



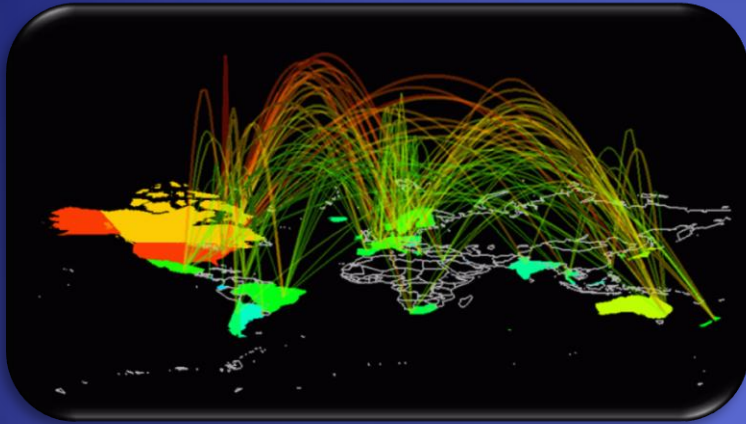
SEES Alignment with NSF's Infrastructure Investments

- ▶ NSF developing *Cyberinfrastructure Framework for 21st Century Science & Engineering (CIF21)*
 - Geographically distributed, locally-available cyberinfrastructure
 - Advanced computing resources and software environments
 - Advanced networks and data storage capabilities
- ▶ SEES/CIF21 intersection
 - New generation of experimental and observational networks
 - Data analysis, modeling, simulation and intelligent decision-making facilitated by advances in computational science

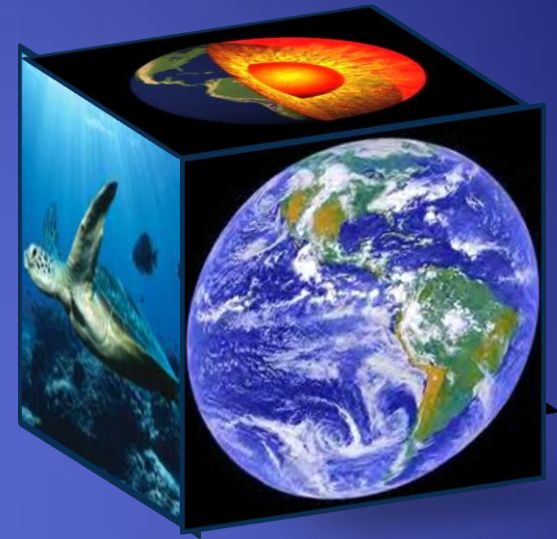


Overall Vision:

Building on the Internet Paradigm: An “Earth Cube”



Internet for
interoperability



Interworkability
for collaboration

- The Internet provided a knowledge system that transformed the modality of science
- CIF21 investments must provide a framework of integrated and interactive services that support understanding and prediction of the Earth system as a whole



NCAR–Wyoming Supercomputing Center

- ▶ Construction began June 2010, proceeding on schedule.
 - Concrete work and steel erection.
 - Installation of gas line, electrical feeds (by Cheyenne Light Fuel and Power).
- ▶ RFPs for supercomputer, data storage and data archive was released in December 2010.
- ▶ System will be 1–1.5 Pflops peak”
- ▶ No significant issues or areas of concern and none are currently anticipated.



NWSC Webcam 05-10-2011

NSF Funding for Construction

2010	2011	Total
\$31 million	\$17.1 million	\$48.1 million

MILESTONE	DATE
Completion of Construction	August 2011
Supercomputer and Data Storage Procurement	RFPs: December 2010 HPC Delivery: January 2012
Transition from Boulder	Begins: August 2011
Start of Full Operations	July 2012 (friendly users)

FY10: CRI —Starting (and continuing) point for SEES

▶ CRI: Climate Research Investment



- ▶ Emphasis on climate and environment, including human sciences
 - Water, Sustainability, and Climate (WSC)
 - Ocean Acidification (OA)
 - Dimensions of Biodiversity (DB)
 - Climate Change Education (CCEP)
 - Regional and Decadal Earth System Modeling (EaSM)

CRI Statistics

WSC	OA	CCEP-1	BD	EaSM
Letters of Intent				
311	130	174	288	174
Number of Projects				
171	106	110	195	137
Funding Amounts in FY 2010				
\$16 M	\$12 M	\$12 M	\$26 M	\$0 M

Notes: FY10 competitions resulted in:

- 70 awards totaling \$66M (FY10) and \$19M (FY11)
- EaSM awards to be made in FY11, including DOE and USDA funds

FY10 awards

SEES News Releases

- **News Release:** [NSF Awards Grants to Study Effects of Ocean Acidification \(NSF 10-186\)](#) (October 13, 2010)
- **News Release:** [NSF Awards Grants for Study of Water Sustainability and Climate \(NSF 10-182\)](#) (October 6, 2010)
- **News Release:** [NSF Awards Grants to Study Dimensions of Earth's Biodiversity \(NSF 10-179\)](#) (October 5, 2010)
- **News Release:** [Climate Change Education Partnership awards \(NSF 10-165\)](#) (September 10, 2010)
- **News Release:** [Improving Predictions of Climate Change and Its Impacts \(NSF 10-044\)](#) (March 22, 2010)
- **JOINT NSF, DOE, and USDA PRESS CONFERENCE:** [New interagency program to improve predictions of climate change and its impacts](#) (March 22, 2010)

SEES Related News Releases

- **News Release:** [NSF Awards Grants on Interactions Among the Environment, Economy and Society \(NSF 10-194\)](#) (October 19, 2010)
- **News Release:** [NSF Awards Grants for Research on Coupled Natural and Human Systems \(NSF 10-198\)](#) (October 21, 2010)



[Return to SEES Homepage](#)



SEES Focal Points for FY1 1

- ▶ Enhance existing SEES portfolio
- ▶ Support sustainable energy research and socioeconomic, environmental, and educational implications
- ▶ Respond to NSB Sustainable Energy report
 - ▶ Systems approaches to **research** programs, **education** and **workforce** development, public awareness and **engagement**
 - ▶ **Partnerships** with other agencies, states, universities, industry, international organizations



FY 11 NSF SEES Activities

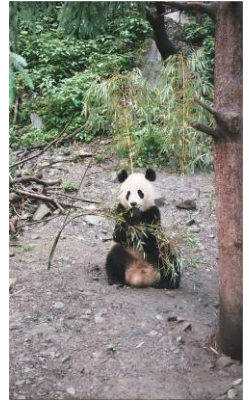
Dear Colleague Letter

- ▶ Highlights NSF's unique role to support research and education to understand complex sustainability issues
- ▶ Describes scope of SEES Portfolio
- ▶ Directs PIs to SEES web site, www.nsf.gov/sees
- ▶ Highlights FY11 SEES activities
 - ▶ Coupled Natural Human systems solicitation (NSF 10-612) encourages SEES themes
 - ▶ Catalyzing New International Collaborations
 - ▶ Research Coordination Networks solicitation (NSF 10-566)
 - ▶ Interdisciplinary workshops



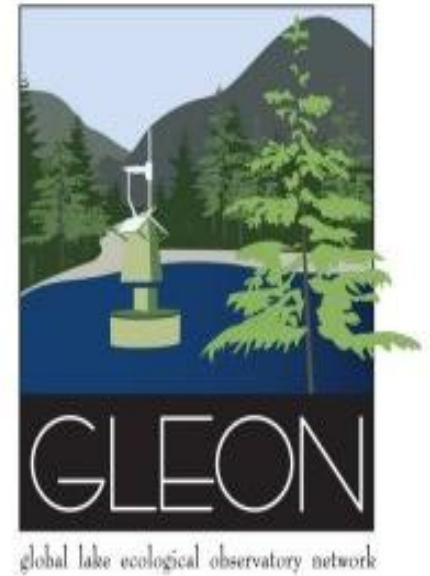
Dynamics of Coupled Natural and Human Systems (CNH)

- CNH (NSF 10–612) encourages SEES themes
- Interdisciplinary standing NSF program (GEO, BIO and SBE).
- Quantitative, interdisciplinary analyses of human and natural system processes and complex interactions at diverse scales
- Adds support for exploratory/new team awards and Research Coordination Networks



Research Coordination Networks

- Supports groups of investigators to communicate and coordinate efforts
- across disciplinary, organizational, institutional and geographical boundaries about a common theme.
- NOT funding a research project
- Include diverse range of career states
- A research theme – question, phenomenon, organism, technology, technique, disciplinary boundary, ...



FY 11 Activities – planned

Sustainability Research Networks

- To help build & expand the interdisciplinary community of investigators researching sustainability science and engineering:
 - Addition of a new **SEES** track in the **Research Coordination Networks (RCN)** competition
 - New solicitation for **Sustainability Research Network Competition** is being drafted

SEES/CRI Competitions

- ▶ **Climate Change Education Partnership (CCEP): FY11:**

Supplemental funding to FY10 awardees
FY12: CCEP competition expected

- ▶ **Dimensions of Biodiversity**

FY11: January 2011 deadline;
FY12: annual competition expected

- ▶ **Ocean Acidification**

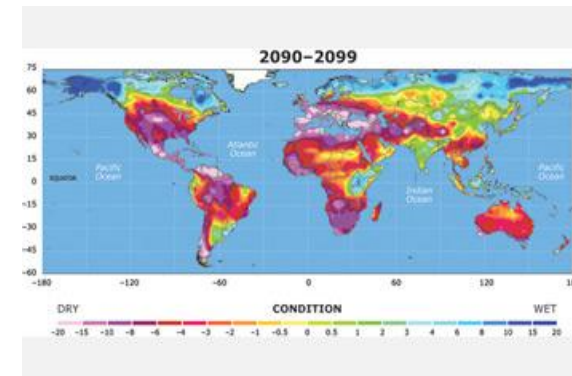
FY12: Solicitation to be revised in
2011 to spend FY12 funds

- ▶ **Water Sustainability & Climate**

FY12: Solicitation revised in 2011 to spend FY12 funds

- ▶ **Decadal & Regional Climate Prediction using Earth System Models (EaSM)**

FY11: Funds to spend on proposals received in 2010
FY13: Anticipate revised solicitation to spend FY13 funds

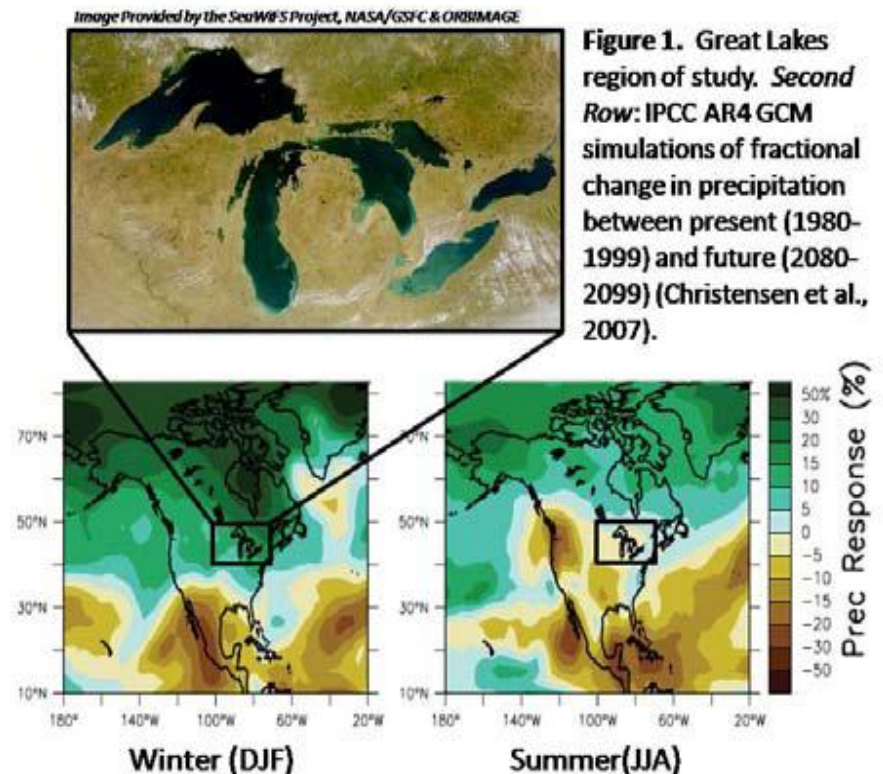


Example Water Sustainability and Climate Award (17 awards total)

Research Questions:

- ▶ *What are the possible effects of climate-change-induced extreme events on water quality and ecology in the Great Lakes system?*
- ▶ *What management strategies would be effective to address these changes?*

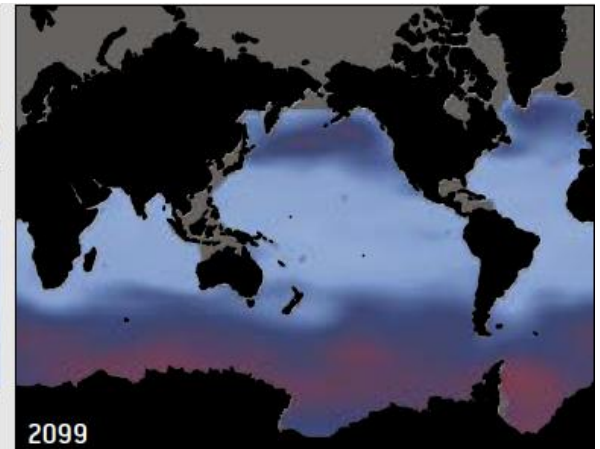
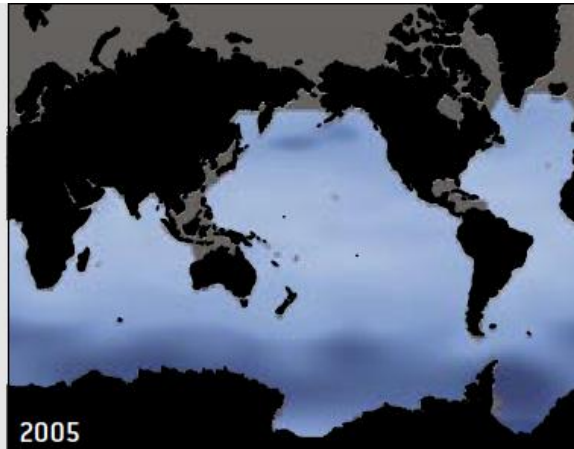
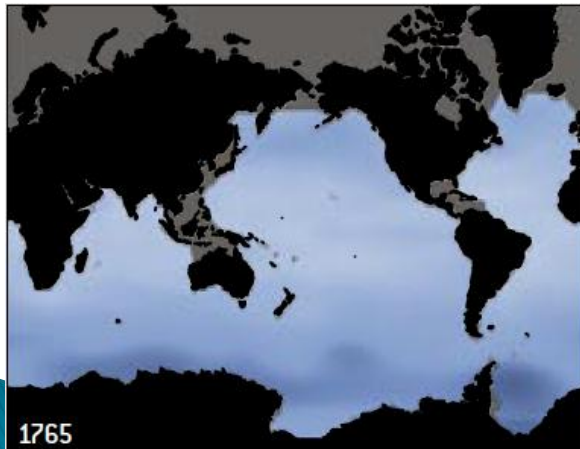
PI: Michalak, U. of Michigan
(Extreme events impacts on water quality in Great Lakes)



Example Ocean Acidification Awards (24 awards total)

Research Questions

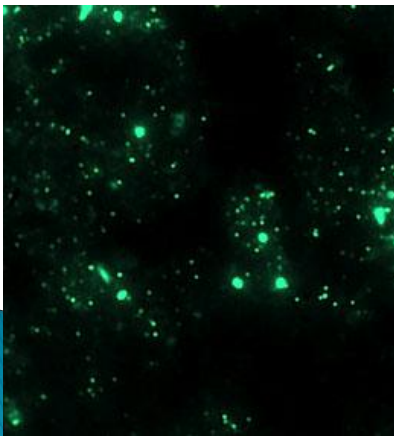
- *What are the effects of $p\text{CO}_2$ and pH on Photosynthesis, Respiration and Growth in Marine Phytoplankton ?*
 - PIs: Francois Morel, Princeton University and Brian Hopkinson, University of Georgia
- *What are the effects of Ocean Acidification on Coastal Organisms: an Ecomaterials Perspective ?*
 - PI: Emily Carrington, University of Washington



Saturation State of Aragonite

Example Dimensions of Biodiversity Awards (14 awards total)

- ▶ Goal: Characterize biodiversity using a novel approach that focuses on the intersection of taxonomic, genetic and functional diversity
- ▶ Two example projects:
 - How does plant diversity affect the resilience of Asian and US forests to global/climate change?



- Do viruses structure microbial biodiversity in deep sea sediments and so measurably impact the release of the methane from the oceans to the atmosphere?

Examples of Climate Change Education Partnership Awards (15 awards total)

▶ **Applying Proven Learning and Communications Strategies to Climate Literacy in the San Diego Region**


- Will use opinion leaders to increase awareness of climate science, mitigation, and adaptation issues
- PI: Michel Boudrias, University of San Diego



▶ **Urban Climate Education Partnership**

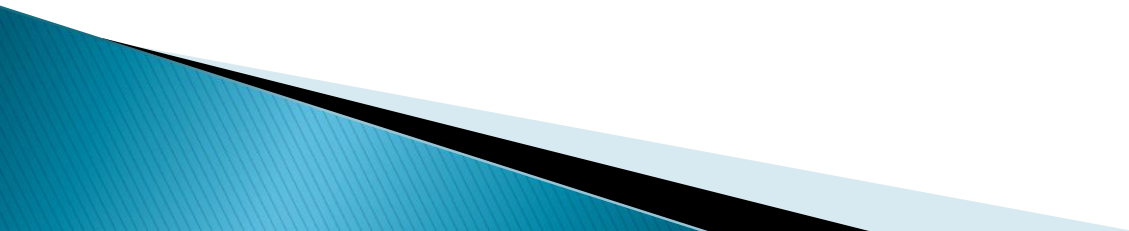
- Will link informal and informal climate education partners and policy makers in four urban centers--Philadelphia, Pittsburgh, Queens, NY, and Washington, DC
- PI: Steven Snyder, Franklin Institute Science Museum

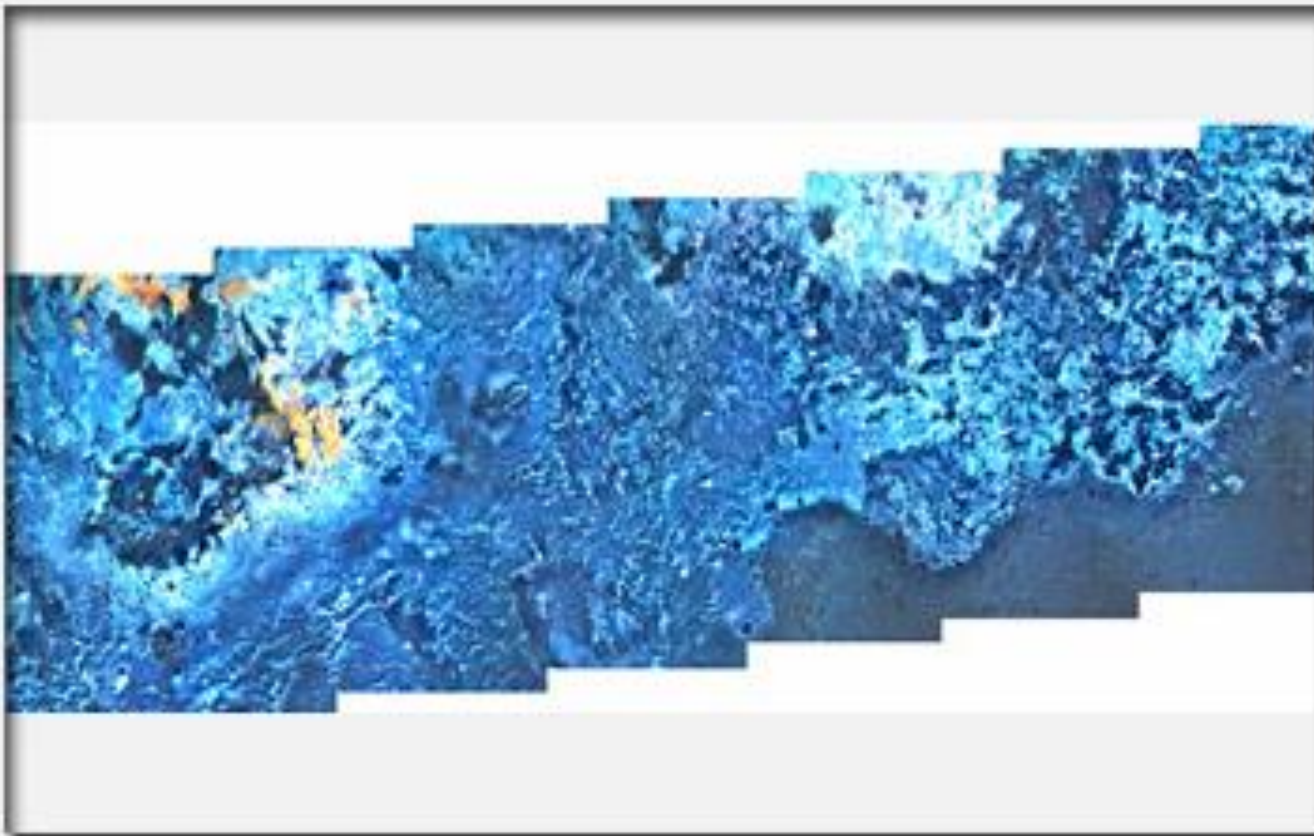
EaSM Summary

- ▶ NSF, DOE, USDA interagency effort
 - ▶ Primary Goals
 - Achieve comprehensive, reliable global and regional predictions of decadal climate variability and change
 - Quantify impacts on ecological, agricultural and other human systems
 - Maximize the utility of data for impact assessments
 - Translate model results into basis for management decisions
 - ▶ Awards support development of next-generation Earth System Models by interdisciplinary teams
 - Coupled and interactive representations of ecosystems, agricultural lands, urban environments, biogeochemistry, atmospheric chemistry, ocean and atmospheric currents, the water cycle, land ice, and human activities
- 

Science, Engineering and Education for Sustainability (SEES)

Images from FY 2010 Climate Research Investment
Awards





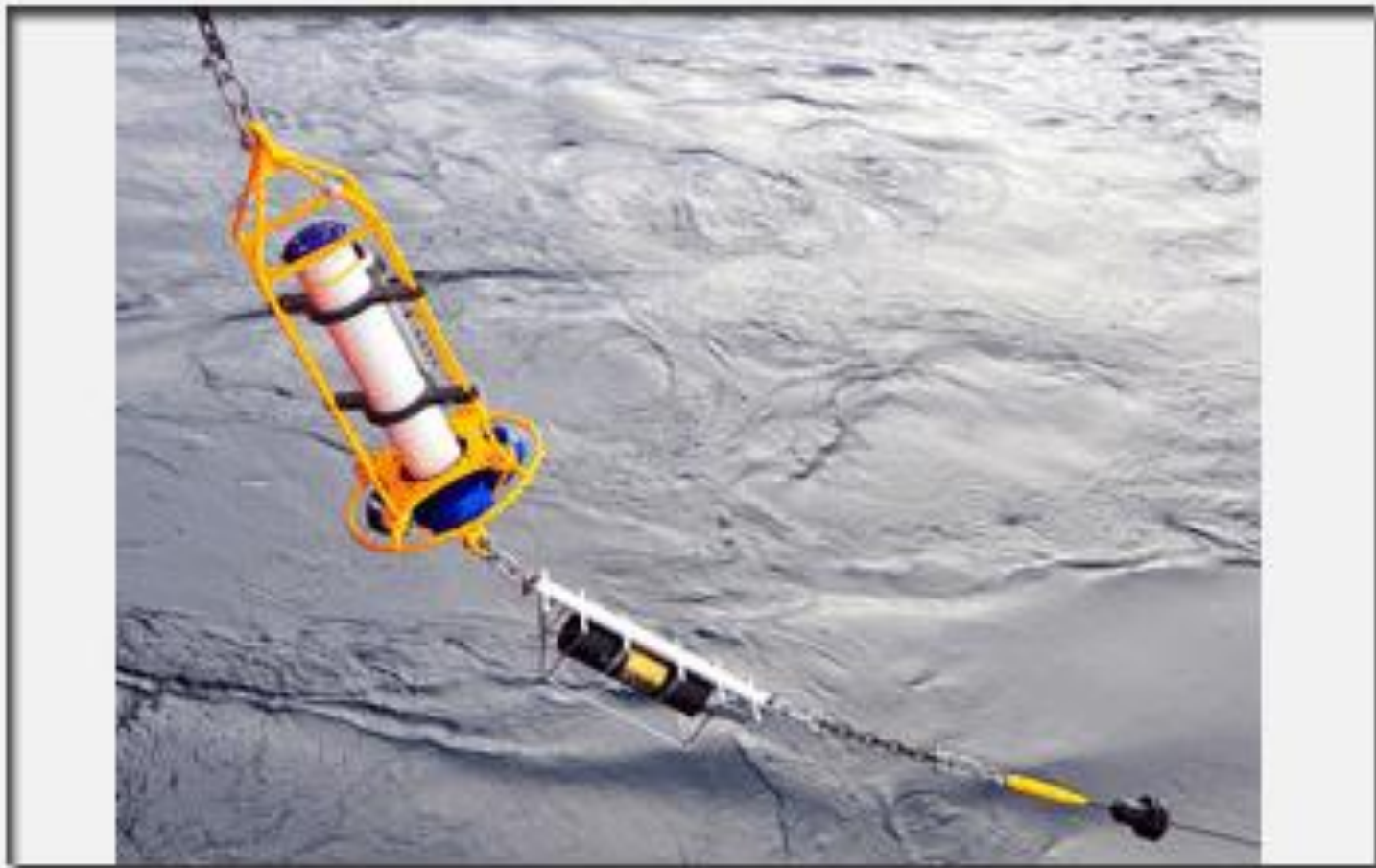
Ocean sediment microbes form a unique ecosystem where methane is consumed.

Credit: David Valentine



Bill Morris and Alex Rose measure plants in an alpine cirque above Kennecott, Alaska.

Credit: Daniel Doak



A biogeochemical mooring monitors ocean acidification in the western Arctic Ocean.

Credit: Rachel Fletcher



Irrigation using pumped groundwater plays a crucial role in sustaining agricultural production.

Credit: Mike Mahaffie



Porcelain crabs just before and after hatching.
Credit: Jonathon Stillman, SFSU



Water availability and land-use activities lead to complex patterns of vegetation in Zambia.

Credit: Tom Evans, Indiana University



South Africa's Cape Floristic Region is one of the world's plant biodiversity hotspots.

Credit: Jane E. Carlson

2012 and Beyond – Planned Future SEES Activities

- ▶ Build out Sustainability Research Networks
- ▶ Postdoctoral fellowship solicitation targeted at interdisciplinary SEES Fellows
- ▶ Partnerships for International Research and Education (PIRE) solicitation – SEES focus
- ▶ Solicitation(s) on vulnerable geographic regions, including coastal and the arctic.
- ▶ High level, multi-agency, multi-sector SEES summit



International Leadership

- NSF Partnerships for International Research and Education
- International Council of Scientific Union (ICSU) Grand Challenges:
 - Forecasting
 - Observations
 - Thresholds – abrupt change
 - Responses – institutional, economic and behavioral changes
 - Innovation
- To meet these challenges we need:
 - Enhanced capacity to undertake interdisciplinary and transdisciplinary research
 - Development of a new generation of scholars taking a systems approach to problems of global sustainability



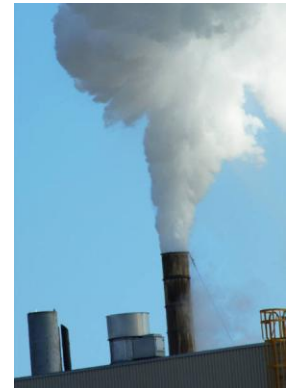
Understanding NSF's Unique Role

- ▶ Most well connected of any government or industry to world's greatest brain trust
 - U.S. Colleges and Universities + K-12 STEM education community
 - A coalition of willing participants
- ▶ Long history of supporting research that contribute to sustainability knowledge
- ▶ We have made a start!
 - Innovator in fostering interdisciplinary research
 - Productive relationships with Federal agencies and International partners
 - CRI Investments; SEES Portfolio investments



OMB/OSTP Science & Technology FY12 Priorities

- Moving toward a clean energy future to reduce dependence on energy imports while curbing greenhouse gas emissions
- Understanding, adapting to, and mitigating the impacts of global climate change
- Managing competing demands on land, freshwater, and oceans for production of food, fiber, biofuels, and ecosystem services based on sustainability and biodiversity



**“After four decades of studying these issues,
I’ve concluded that energy is the core of the
environment problem, environment is the
core of the energy problem, and resolving
the energy–economy–environment dilemma
is the core of the problem of sustainable
well–being for industrial & developing
countries alike.”**

-- John Holdren



Thanks



NATIONAL SCIENCE FOUNDATION